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Effect of microstructure on high-cycle fatigue properties of Alloy718 plates

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High-cycle fatigue properties of Alloy 718 plates were investigated at 77 K in this study. Two plates were used and had a normal-grained and a bimodal-grained (BG) microstructure, respectively. Regarding the normal-grained plate, we prepared two specimens that had different grain sizes by controlling solution-treatment conditions. One had a fine-grained (FG) microstructure and its mean grain size was 40 μm. The other had a coarse-grained (CG) microstructure and its mean grain size was 100 μm. On the other hand, the BG specimens were obtained after the same heat treatment as that of the FG specimens. However, it consisted of the FG and the CG regions. Mean grain size of each region was 30 μm and 100 μm, respectively.
High-cycle fatigue strength of the FG specimens was higher than that of the CG specimens. High-cycle fatigue strength of the BG specimens was almost the same as that of the CG specimens. In the observation of fracture surface, flat area (facet) was found at fatigue crack initiation site in all specimens. Each facet size was similar to the grain size of each specimen and about 100 μm in the CG and BG specimens. Observations of the microstructure beneath the fatigue crack initiation site of the BG specimens revealed that the facet corresponds to transgranular cracking in the course grain, meaning that fatigue crack initiated at the coarse grain in the BG specimens. Thus, it is surmised that the high-cycle fatigue strength of Alloy 718 with the BG microstructure is strongly affected by that of the CG region in that material.

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